solplan review

the independent newsletter of energy efficient building practice

the drawing-room graphic services ltd.
box 86627 north vancouver b.c. V7L 4L2

No. 13

February-March 1987

INSIDE....

Windows are a significant component in any house. They are important to consider as they are the weakest link in the thermal envelope. In this issue Michael Glover reviews the state-of-the-art in super window technology: what is being done and suggestions for developing a window rating labeling program.

We have prepared an R-value table of typical currently available window units. New R-2000 Program technical requirements stress the need for balanced ventilation, and the need to avoid pressure imbalances in the house. Make-up air sizing methods are provided. Ted Kesik and Michael Lio comment on some of the potential problems with the methods suggested.

A recent study of furnace filters has studied the performance of medium efficiency filters, in comparison with conventional rock catchers and electronic filters. The results indicate some interesting findings.

Allen Crocket shares with us an alternative method of sealing polyethylene he has discovered, and which seems to work. It may be of interest to others.

Other items include news on product modifications just made by Fiberglas Canada, about studies on the thermal performance of rigid insulation boards (they're not as effective as claimed), letters from readers, and more.

CONTENTS

SUPER WINDOWS

FROM THE PUBLISHER

The construction industry has an image problem. Steps have begun to be taken to upgrade the industry's standards. Programs such as the education component of the R-2000 Program are making a significant impact. Provincial CHBA groups are taking steps towards a contractor licensing process. In some provinces, statutory regulations already exist to control who participates.

However, the image and reputation will ultimately be determined by the performance of the industry no matter what the regulations. After all, quality and good manners cannot be mandated!

I have noted that although there may be many conscientious and reputable builders, far too many are more interested in the short term. Why is it that concern for quality is of interest and stressed during slow markets? When the housing market is very healthy there is less attention paid to it?

For example, there is a recognition that construction to R-2000 standards represents a standard of quality. Yet there seems to be a slow down in R-2000 starts in a booming market. Program participation is used to gain a competitive edge only in a slow market. Presumably if there is merit in building R-2000 in a slow market, why not in a booming market?

If builders are ready ready to build anything just because it can be sold it just maintains the image of the industry as one with many fast buck artists.

The attention to detail and quality is necessary at all times. The quality builder should not be afraid to stick to what he believes in even in a booming market. There is no reason why most housing starts shouldn't be R-2000.

My stress on the R-2000 standard is not just because of my personal involvement with the program. Rather it is because I believe that it represents a workable (despite it's shortcomings) program to deliver quality housing in a manner that is consistent with the marketplace. It is a program that is beginning to receive public recognition.

It represents the state of the art in residential construction and it offers a performance standard that is both flexible and can be met without resorting to heroic excesses of effort or cost. It does not mean that it can't be improved upon, or that the performance criteria cannot be modified or exceeded.

If the construction industry doesn't begin to take advantage of this on a wider scale, then it's going to be left in the dust as others come along to provide a housing product that offers what the public wants at an affordable cost (with all the bells and whistles) for less money than conventional stick framing.

Richard Kadulski
Publisher

EBBA CONFERENCE: DATES SET

In the last issue we mentioned that the **5th Annual Energy Efficient Building Conference and Exhibition** (originally scheduled for Seattle in April) was postponed.

We have just heard that the conference will be held **April 10-11, 1987** in Minneapolis, Min. For more information, contact: Jeanne Brownback, EBBA, Box 1115 Pine Island, MN 55963. Tel. 507-285-8752

We wish the organizers luck with planning the conference at such short notice.

SOLPLAN REVIEW is published 6 times per year by The Drawing-Room Graphic Services Ltd. P.O. Box 86627, North Vancouver, B.C. V7L 4L2. Tel: 604-689-1841
ISSN: 0828-6574 Printed in Canada

SOLPLAN is a registered trademark of The Drawing-Room Graphic Services Ltd.
SUBSCRIPTIONS: $24.00 per year in North America
Overseas rates on request.
Unsolicited contributions and manuscripts welcome. Include self addressed pre-stamped mailer if return requested; Publisher is not responsible for loss or damage of same.
Second Class Mail Registration No. 6855
Date of Issue: March 1987

SUPER WINDOWS

by Michael Glover

Our lead item this issue is based on notes for a talk presented at an EMR Industry Seminar on Super Window Technology held in Toronto, Nov. 5, 1986. It is an excellent overview of the current status of developments in window technology.

The term "superwindow" covers a wide range of performance, typically from R-4 to R-10. (Coventional double glazing is about R-2.)

LOW EMISSIVITY COATINGS (Low E)

The high-tech component of superwindow technology is the low-emissivity coating which allows light to enter but prevents the outflow of heat radiation.

There are two main types of low-E coatings, which are termed hard or soft. A hard coating is an oxide coating which is sprayed onto glass at high temperatures. A soft coating is a thin layer of metal sandwiched between two protective oxide layers which are deposited on the glass or film. Most low-E glass now on the market is soft coated.

The advantage of a hard coating is durability and potentially lower cost, as the coating can be applied during the float glass production process. Equipment is expected to be less capital intensive than the vacuum equipment required for the soft coating. Although a technical breakthrough is always possible, the emissivity of hard coatings presently on the market remains relatively high at around 0.4, although 0.2 is considered to be the practical limit.

(Emissivity is a measure of the amount of absorptance of incident energy on glass. The lower the emissivity, the more effective the coating.)

The performance of a soft coating is around 0.1 and performances of 0.05 or lower can be achieved. Soft coatings are presently manufactured by vacuum sputtering thin coatings onto glass or film. The coating incorporates minimal material and requires little production labour, but the coating is relatively expensive due to the high capital cost of the production equipment. There is potential for reducing the cost of the coatings by increasing the production of the very capital intensive equipment.

One way of reducing costs is by using electron beam evaporation. This is a technology now being used by the Bank of Canada in Ottawa for applying complex anti-counterfeiting multi-layers. This is about ten times faster than sputtering. This technology leads the world in optical thin-film technology. The challenge is to apply the new technology to the window industry.

LOW CONDUCTIVE GAS FILL

A low-E coating reduces radiation heat loss. For maximum effectiveness, the low-E coatings are used in combination with an inert gas to also reduce conduction and convective heat losses. At present, argon is the most widely used inert gas fill.

The material cost of argon gas is trivial, though the cost of installation off line is relatively high. In Europe, where use of inert gas is more widespread, there have been problems of "exploding" sealed units due to units being under- or over-pressurized when the inert gas is added during production.

Repla Ltd. is carrying on pioneering work on the development of a vacuum chamber method. With this new method, the amount of inert gas fill is consistently well above 95% and there is no possibility of under- or over-pressuring the units.

The Lawrence Berkeley Laboratory (LBL) Window Research Group is carrying out analytical work on krypton/argon gas mixtures. For very low conductive krypton gas, the optimum air space for thermal insulation is reduced from 1/2 inch to 1/4 inch. Research grade krypton gas is, however, relatively expensive.

The significance of the LBL research is that the krypton gas can be mixed with a relatively large percentage of argon gas with only a marginal loss in thermal performance. It is projected that a mixture of argon and krypton gas can be produced at a cost about one third the cost of pure krypton.

This development is particularly important for the retrofit market. A conventional R-2 sealed unit with a 1/2 inch airspace could be replaced by an R-8 unit

consisting of a triple glazed unit featuring a low-cost inner plastic film glazing layer, two high performance low emissivity coatings on the glass panes, and two 1/4 inch "air spaces" filled with krypton/argon gas mixture.

INSULATED SPACER

The third component of superwindow technology is the insulated spacer. Analytical studies at Lund University in Sweden have shown that an insulated spacer can reduce heat loss through the sealed unit by about 5% and through the window frame by about 30%.

In Canada, the insulated spacer market has been pioneered by Omniglass Ltd. with a fiberglass pultruded spacer. A variety of other insulated spacers are under development using lower cost plastic materials and production methods which are cost competitive with metal spacers.

(A pultruded component is like an extrusion, except that the fibres are pulled through the mould.)

In addition to reducing heat loss, the importance of insulated spacers is that they overcome the problem of edge condensation. For high performance insulated sealed units with low-E coatings, an insulated spacer is critical in overcoming the problem of cold weather thermal stress.

On extremely cold sunny days, the centre of the glass is constrained from expanding by the cold glass at the perimeter in contact with the metal spacer, which could be shaded by window frame or reveal. As a result, the glass is stressed and, in extreme cases, the glass pane can break due to the thermal stress.

ENERGY EFFICIENT WINDOW FRAMES

Improvements have been made to window frame design, including more durable and resilient weather stripping, improved hardware, and lower conductive frame materials.

The majority of windows in Canada are constructed using the Truth hardware system. Most homeowners who operate windows which incorporate Truth hardware know the deficiencies of the system where the window sticks in cold weather, where the handle gears are stripped and where the airtightness of the weather stripping is ineffective after a few years.

Improved hardware systems are available, such as the "Turn and Tilt" system widely used in Europe. The "Turn and Tilt" system is often used in combination in PVC plastic profiles. For larger windows, the PVC plastic profiles have to be re-enforced with metal sections which act as thermal bridges and lower the energy efficiency of the window frame assembly. More rigid plastic frame materials such as pultruded fiberglass profiles which do not require metal re-enforcing profiles are beginning to become available.

A further advantage of the higher performance rigid plastic frames is that the area of the window frame profile can be reduced. The area of the window frame and related structural framing is typically between 25 and 30% of the area of the glazing. Reducing the area of the window frame to around seven percent of the area of the glazing reduces conductive heat losses and also increases passive solar gains.

Studies by Enermodal Engineering have shown that for a typical house with majority of the windows on the south side, the energy savings are between 4-5 GJ or $45-50 in energy savings per year simply by reducing window frame area to 7%.

POTENTIAL OF SUPER WINDOW TECHNOLOGY

Superwindow technology has significant potential in Canada for reducing long-term energy demand. By upgrading conventional R-2 windows to R-8, there is a maximum saving of about 1 GJ per square metre depending on location, building type, orientation of the building, etc.

There are about 5 million square metres (53 million sq.ft.) of insulated glazing installed in Canada each year. If all the windows installed were upgraded to superwindow standards, there would be a savings of approximately 5 million gigajoules (or 5 petajoules), roughly 1.5 million megawatts of energy per year. After twenty years, the maximum cumulative annual savings each year would be around 100 petajoules. A realistic target after twenty years might be half that, about 50 petajoules.

A gigajoule of energy in Canada today costs about $10. The maximum potential savings over 20 years is $1 billion at today's energy prices and a realistic goal is $500 million. Depending on the area of glazing, each homeowner with R-8 superwindows would save between $100 and $200 per year in energy costs at today's prices.

In the United States, some of the national window manufacturers (such as Anderson and Marvin) are switching their entire production over to high performance sealed units. With superwindows made in quantity, the incremental cost of R-4 window units is reported to be about 5%.

With large-scale production, the potential of an one year payback for the consumer is possible.

PROMOTION OF SUPER WINDOW TECHNOLOGY: The Case for New Labeling Standards

At present in Canada, superwindows are custom made and consumers pay a premium for the higher performance units. The challenge is to realize economies of scale.

One way to establish consumer confidence is through improved standards and testing methods for the performance and durability of superwindows. A labeling system similar to the Energuide stickers for kitchen appliances would be a useful first step. If a credible labeling system was in place, it would be much easier to persuade governments to promote superwindow technology through such programs as the R-2000 program. Architects, building designers, and builders would be in a better position to specify a particular performance and know that they would obtain a reliable product of known performance.

For the window industry, basic standards and approval procedures are already in place. The labeling system should build upon the existing extensive infra-structure for quality assurance and not be a separate approval step.

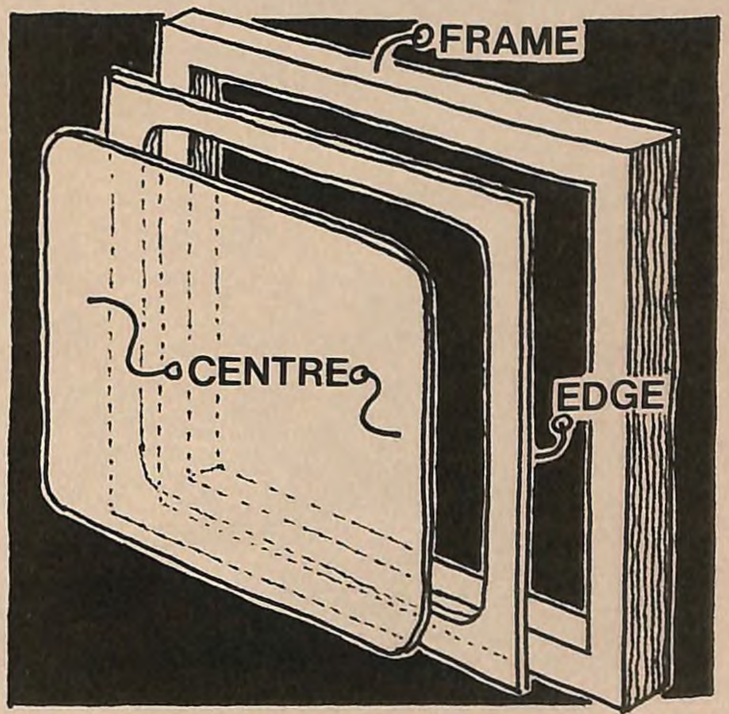
A major drawback to large scale implementation of superwindows is the structure of the Canadian window industry. It is very fragmented, with many small, local (and probably under capitalized) companies. There are 150 small window manufacturers located in Montreal alone. To gain acceptance and to be affordable, the labeling system must be built on detailed testing of individual components, such as hardware, weatherstripping, and low-E coatings. Detailed thermal performance testing of all windows on the market is not a feasible proposition.

PERFORMANCE LABELING OF SUPERWINDOWS

Performance labeling of superwindows, does not require infite accuracy. It does not particularly matter if the performance of a window is R-2.5 or R-2.6. What is important is to know whether the window has a value of R-2 or R-8.

For overall thermal performance, an equally important factor is the air-tightness of the window. The labeling system should initially focus on simple heat loss because air-tightness can be evaluated by the consumer by examining weatherstripping and hardware or during an airtest of the house. In contrast, superwindow technology is not visible. The consumer must be convinced that "the emperor does have clothes" and that for two windows that look alike, one window can be R-2 and the other R-8.

The labeling system should include both heat loss from the sealed unit centre zone and heat loss from the frame and the edge spacer or perimeter zone. To reduce the cost of operating the labeling system, it could be based on computer analysis rather than on detailed testing of all window designs offered by a manufacturer. This is



There are thee separate parts of windows that must be considered when evaluating window performance: the centre of the window (i.e. the glass alone), the edge, and the window frame.

because of the wide number of possible window design options which a larger window manufacturer may offer. For example, if a manufacturer offers twenty standard sizes, with different sealed units (R-2, R-4, and R-8) with five model types (casement, sliders, etc.) with plastic or wood frames, and different options for insulated spacer, muntin bars, weatherstripping and installation attachments, there could easily be over 10,000 options.

The estimated cost of a single test to the proposed ASTM standard for thermal performance testing is $3,000 so that if testing were required for all options, the overall cost of thermal performance testing for the window manufacturer could be millions of dollars.

CENTRE ZONE

For the centre zone of sealed units, existing specialized computer programs (such as VISION) can be used to predict the thermal performance to the required level of accuracy, assuming that the input data to the program is correct.

One important input is the emissivity of the coating, since the overall performance of the sealed unit varies significantly depending on the performance of the coating. Without standard testing methods, comparative evaluation of coating performance is not simple, as several assumptions have to be made to establishing the performance curves.

The National Fenestration Council in the United States is developing a standard method of measuring the performance of low-E coatings. In Canada it would be quicker and easier to appoint one group to carry out an independent assessment of the different coatings on the market. There are essentially four major glass producers, so this should not be a major task. The group selected must acquire the appropriate testing equipment so that the emissivity of the coating on both glass and film can be accurately measured. This equipment is not generally available in government laboratories at the present time.

A second important input to the VISION computer program is the amount of inert gas fill that can be achieved in production. Depending on the production methods used, the amount of inert gas within the sealed unit can vary from 60 to 95% or more. Standard testing and quality control procedures are needed to measure the percentage of inert gas fill achieved under factory conditions. The procedures should also assess whether the sealed unit is being either under- or over-pressurized.

PERIMETER ZONE

In contrast to the centre zone of a sealed unit, it is much harder to predict the thermal performance of the edges of the window. A computer program to calculate the thermal performance of different edge frame options is being developed by Enermodal Engineering Ltd., (supported with funding from Energy, Mines and Resources). It is important that this work is supplemented by an extensive testing program of different standard edge conditions.

With these research projects completed, it will be possible to determine whether a sufficiently reliable computer method can be developed for estimating the thermal performance of different edge conditions. For unconventional window frame designs, the computer analysis would need to be supplemented by direct testing of representative window designs.

BOUNDARY LINE CONVENTIONS

In determining the thermal performance of a window, a related task is to define the boundary between the centre zone and perimeter zone of the window and between the perimeter zone and the building wall.

If these boundary line conventions can be developed, they can be incorporated into building energy analysis computer programs such as HOTCAN and ENERPASS. The end result should be that the task of data input would be simplified and the accuracy of the programs improved.

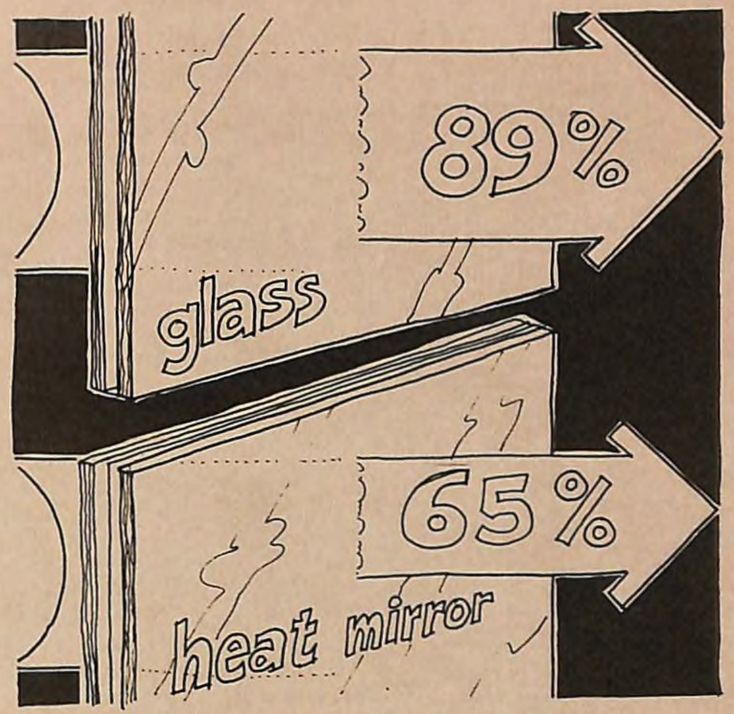
DURABILITY TESTING OF SUPER WINDOWS

The Canadian methods for testing insulated sealed units were developed in the early 1960's under the leadership of the National Research Council's Division of Building Research. These standards reflected the state-of-the-art of sealed unit technology at that time.

Although sealed units continue to be tested to these standards, the testing procedures do not adequately address the

potential durability problems of the new materials used in sealed glazing units. New testing procedures are required to be developed to address three key issues:

* degradation of the performance of low-E coatings,
* long-term diffusion of inert gas fill,
* degradation and outgasing of plastic materials within the sealed units (spacers, muntin bars, films, etc.)



WINDOW R VALUES

Suppliers sometimes give incorrect R-values or overstate the R-value of their windows glazings.

The standard reference list for window R-values is that prepared by ASHRAE. Window coefficients are difficult to determine because of the inherent nature of a window, which is difficult to analyze. The R-value of a window is a combination of the center glass area (which can be calculated and/or measured relatively well), the edge effect (which is difficult to predict and depends on the type of spacers), the type of window frame and site conditions.

Windows of different sizes will perform differently, as the proportion of the edge conditions will vary. Thus a test performed on one size will be different from a window of a different size. There is some evidence from recent tests in the USA that many windows have R-values considerably different from that claimed by the manufacturer (or the ASHRAE list).

Controversy exists about the assumed outdoor conditions (which assumes a 15 mile per hour wind acting on the window. How reasonable is this assumption?), and how they are modeled in laboratory tests.

The City of Seattle has compiled a list of measured performance values of window units marketed in the city (the list was put together as part of code requirements). Their information shows that there is a wide range of performance. **Double glazed units (1/2" airspace) had R-values ranging from a low of 1.4 to a high of 2.4. Double glazed (1/2" airspace) low-E windows ranged from 1.8 to 2.8.**

Until more definitive information is available, the ASHRAE reference is the one to use. (We understand that ASHRAE and the industry are now working on refining their data).

The R-2000 program is now adjusting the accepted default R-values for standard glazing units used in design evaluation of new houses. In most cases, it means that window R-values are being **downgraded**. This will have the consequence of increasing heat loss from a typical house. Houses with large glass areas **may** have a difficult time meeting the Program budget.

It is important to recognize that the higher performance windows also have a higher shading coefficient. This means that there is less solar transmission through the window. So if passive solar gains are important, they may be affected by the high performance glass. In some cases, this can be taken advantage of. These units can be used for west facing windows to reduce the potential overheating.

We have compiled the table (see next page) of common windows types and their R-values. These are derived from ASHRAE data.

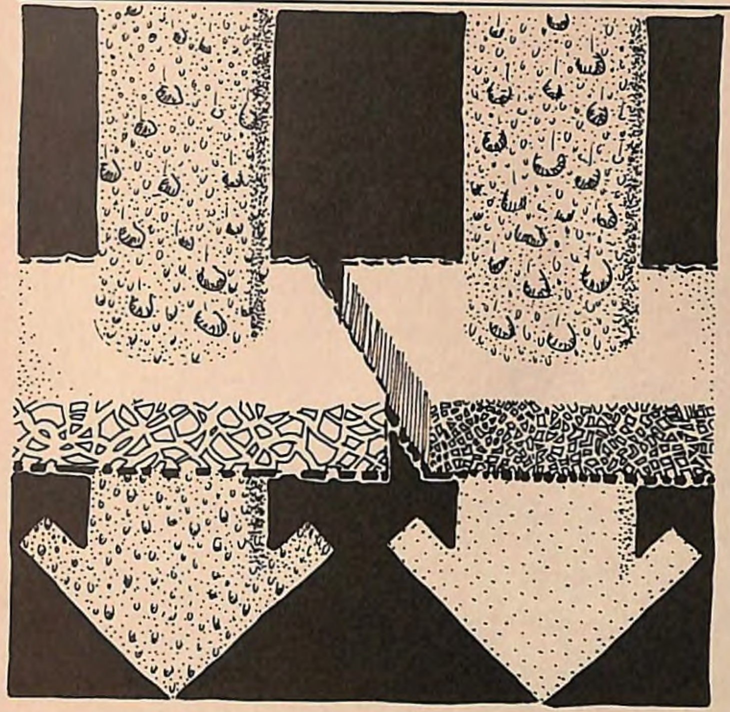
WINDOW RATINGS

This table lists the properties of window units presently on the market. The first of the new generation of super windows that are appearing in the marketplace are the low E and Heat Mirror™ glazings.

WINDOW TYPE		R-VALUE	(RSI)	SHADING COEFFICIENT
SINGLE GLAZING		0.91	(0.16)	.94
DOUBLE GLAZING				
1/4" AIRSPACE	METAL FRAME	1.41	(0.25)	.88
	METAL FRAME, THERMAL BREAK	1.69	(0.30)	.88
	WOOD FRAME	1.79	(0.31)	.88
1/2" AIRSPACE	METAL FRAME	1.69	(0.30)	.88
	METAL FRAME, THERMAL BREAK	2.04	(0.36)	.88
	WOOD FRAME	2.16	(0.38)	.88
1/2" AIRSPACE LOW E	METAL FRAME	2.10	(0.37)	.66
	METAL FRAME, THERMAL BREAK	2.53	(0.45)	.66
	WOOD FRAME	2.78	(0.49)	.66
13/16" AIR SPACE, WOOD FRAME		2.43	(0.48)	.88
TRIPLE GLAZING				
	METAL FRAME	2.32	(0.41)	.80
	METAL FRAME, THERMAL BREAK	2.90	(0.51)	.80
	WOOD FRAME	3.30	(0.58)	.80
	METAL FRAME, THERMAL BREAK LOW E GLASS	4.34	(0.76)	.61
	HEAT MIRROR™ METAL, THERMAL BREAK FRAME	3.84	(0.68)	.65

Note: These numbers are relative, based on ASHRAE data for typical glazing configurations. Shading co efficients are based on 3mm glass. Larger windows which use heavier glass will have a lower coefficient.

MEDIUM EFFICIENCY AIR FILTERS



IMPROVED FILTERS FOR RESIDENTIAL FORCED AIR FURNACES

The creation and maintenance of clean air environments with reduced levels of dust, mould and other pollutants is the objective of good quality housing, especially for those homes where there are smokers or allergy sensitive individuals. In forced air heating systems, air stream filtration offers an opportunity to effectively reduce pollutant levels. However, typical throw away or washable furnace filters are only 5% efficient in removing particular matter, while electronic filters, which can be 70% to 90% efficient, have the disadvantages of high capital cost and possible ozone production.

Low efficiency filters are approximately 10% efficient. They are effective at filtering larger size particles (in the 35 micron plus range), without restricting the airflow. This is the inexpensive ($1/filter) type that should be replaced at least once a month. This type of filter is known as the rock catcher.

Medium efficiency filters (in the 15% to 60% efficiency range) may represent a cost-effective alternative to upgrading the quality of residential ventilation.

CMHC recently commissioned a study to determine the cost effectiveness of medium efficiency filters, compared to typical low and high efficiency filters, with respect to reducing levels of dust, tobacco smoke and mould, and their impact on fan and furnace operations.

The study looked at filters from the point of view of retrofit applications. However, the information is equally relevant to new construction.

As could be expected, medium efficiency filters were found to be significantly more effective than low efficiency filters but less effective than high efficiency electronic filters in removing dust at low velocity ventilation rates.

With respect to cigarette smoke, medium efficiency filters performed as effectively at low velocities as electronic filters; neither appeared to be effective at high velocities. In most cases, the airflow reduction caused by medium efficiency filters was less than 20%, and could be accommodated through simple adjustments. The cost of retrofit procedures was nil for 25mm filters and minimal for thicker media.

Medium efficiency filtration would appear to be a cost effective method of improving air quality when installed with a low velocity continuous ventilation system. It would not appear to be very effective with intermittent high velocity systems. Increased use of two speed air handling systems is therefore recommended. Since medium efficiency filters will get clogged much faster than low efficiency filters, the study could not recommend that medium efficiency filters be considered appropriate for all situations, and recommended that retrofit test procedures be implemented to determine the suitability of specific furnace systems prior to the installation of medium efficiency filters.

Generally, the medium efficiency filters are very efficient (up to 85%) at removing the larger particles, such as lint, pollen and mold spores, (10-30 micron size). The efficiency of removing tobacco smoke is usually much lower, at 5% to 15% (the particle size in smoke is much smaller - in the .1 micron range). Thus the average efficiency is calculated to be 30% to 50%, depending on the filter.

The potential for reducing airflow caused by a clogged filter is greater with the medium efficiency filters than with the low efficiency filters. Proper consideration must be taken in the maintenance of retrofitted systems.

The study found a great variation in the performance of medium efficiency filters tests. It recommended that retrofit test procedures be established to determine the suitability of each furnace system to accept a medium efficiency filter. Ignoring economic considerations, it was noted that there was very little difference between the performance of electronic or medium efficiency filters.

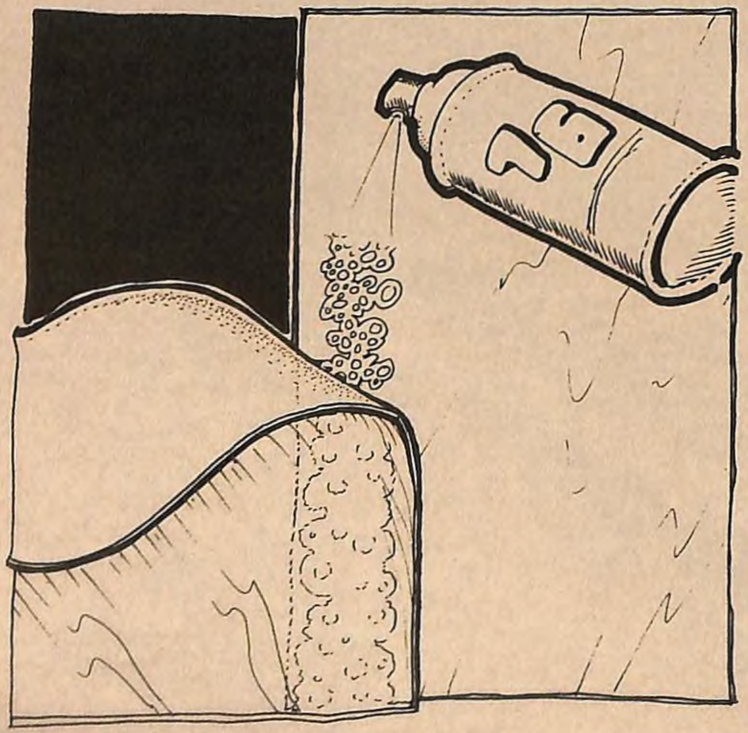
SEALING POLYETHYLENE: ALTERNATIVES

Sealing for air leakage through polyethylene is difficult to accomplish. Our item reviewing tests done at the National Research Council (SOLPLAN REVIEW #11) prompted Allen Crocket of Crocket Construction in Genelle, B.C. to reply.

I thought I should share my experience using a method not mentioned in your report.

I was in a dilemma how to seal poly where there was no backing, such as where a bay window and wall come together. To install backing would have been a chore, to say the least.

A friend interested in R-2000 construction dropped by when I was puzzling the problem, and mentioned that the asbestos removal crew at Cominco was using a spray adhesive to seal poly shrouds used around areas of removal. After the lights went off and the bells stopped ringing, I wrote the 3M company for technical data on their **76 Spray Adhesive**.



I tried it, and it solved the problem of the need for backing in all areas, such as at penetrations by plumbing stacks, electrical conduits, and even joints of the poly/air/vapour barrier. I used the adhesive to seal the header area by cutting the poly to fit around the floor trusses and then sealed directly to the sides of the trusses and the subfloor, then stapled through the glue joints to help hold the poly during the air test, as we were unsure of how much pressure was going to be applied.

We used **Tu-Tuff** poly throughout the house and found this to be extremely strong, easy to work with, and unaffected by the adhesive. We were able to seal all holes right down to the staple holes, quickly and easily and thereby able to achieve an air tightness test of .57 air changes per hour.

I will add that that some of the joints had been sealed for at least 10 months prior to the air test, and we noted no breakdown.

Allen Crocket,
Genelle, B.C.

While the adhesive may work quite well in combination with the **Tu-Tuff** and no backing in some areas, it nevertheless is a good idea to use backing where possible. Redundancy in the system is beneficial. Ed.

Tu-Tuff is a cross laminated polyethylene that is extremely strong and resistant to tearing. It is manufactured by laminating multiple layers of poly with their grains running in different directions.

It is much stronger than conventional poly of the same thickness, and more tear resistant. It is easy to use (it comes in 3 and 4 mil thicknesses), has a lower vapour permeability, and is UV stabilized. However, it is more expensive (we understand it costs about $100 or more per 1000 sq.ft.).

Tu-Tuff is manufactured in the United States and distributed by Sto-Cote Products, Drawer 310, Richmond Ill. 60071. A few suppliers in Canada are be handling this product.

76 Spray Adhesive is manufactured by **3M** Canada Inc. The manufacturer states that the adhesive does not contain any ultra violet screening agents, so it will degrade if exposed to direct sunlight. This breakdown will not occur, however, unless the bond has been exposed to sunlight for approximately one to two weeks.

The life expectancy of the bonded parts (if not exposed to UV degradation) will "last for many years, possibly in the area of 15 years depending on substrate flexibility, and amount of adhesive applied". Delamination of the bonded parts just due to age should not be experienced.

There should be no air escapement between two layers of bonded poly. The overlap bonds should be a minimum of two inches, preferably more. The aerosol dispenses the adhesive in a 'lace-like' spray pattern and the best bond is achieved if both surfaces are coated with adhesive and a contact type bond made.

LETTERS TO THE EDITOR

Sir,

I was disturbed after reading the LEBCO NEWS section in SOLPLAN REVIEW No. 11, and in particular the comments made about Alumi-News.

I am a regular reader of Alumi-News and am a follower of the constituency which it serves. I did not find any violent and unreasoned attacks on government funding, and in particular I did not find any attacks on CHBA and CIAQ. I did however find some very relevant and meaningful questioning going on.

Wouldn't you be asking questions if all of a sudden a guy who's company failed gets one million dollars to "represent" the same people he was selling to? Wouldn't you be asking questions if one branch of EMR is scrambling to find adequate funds to support needed research, standards writing, and industry support activity and another branch, without any coordination gives one million dollars to a guy who's company's product failed in all of the testing carried out by the other branch? Certainly the Wayne Cole/NECA scam is something worth asking questions about and I for one have nothing but admiration for a publication like Alumi-News that has the guts to ask these kinds of questions.

I think the basic objectives of everyone concerned - myself, yourself and Alumi-News are similar; in a era of restraint in government spending we must be critical of wasteful and dubious spending which will give occasion to critics of all spending to attack worthwhile programs. To this end we need honest, open debate and sharing of information and resources. And please, lets get it straight who the enemy is and not waste time bickering with those who are on our side.

Dara Bowser
President, Air Changer Marketing
Mississauga, Ont.

Sir,

Re: R-2000 Ventilation Standards - SOLPLAN REVIEW No. 12. I noted an error in your story. NLA (Normalized Leakage Area) is used in place of ELA (Equivalent Leakage Area) in relation to makeup air requirements. Until the new Air Leakage Test sheet comes out you may have to ask the air tester to give you the ELA as well as the NLA.

I personally disagree with what you suggest (*"most builders will want to try to build-in the make-up at the time of construction.."*) I suspect that most air tightness tests are done mid-way through construction. I would provide a knock-out (sonotube through concrete or a box-thru in wood construction) which can be used to install a U tube at completion or used later when the homeowner intalls the Maytag and the Jenn-Air or whatever.

Tom Hamlin,
CHBA, Ottawa.

Our experience on the West Coast is that in most cases air tests are done when the house is completed (or at least drywall in place). There is a hesitation to do an airtest prior to drywall as the test may damage a caulked polyethylene vapour barrier. Ed.

To clear up any confusion that may exist in our reader's minds about the difference, the ***Equivalent Leakage Area*** *or* ***ELA*** *is a measure of the total openings in the envelope if they were to be measured and added up. The ELA will be given as $\underline{x}$ in^2 (or cm^2).*

The ***Normalized Leakage Area*** *or* ***NLA*** *is a measure of the total openings in the envelope per unit area. NLA is given as $\underline{x}$ in^2/ft^2 (or cm^2/m^2).*

MAKE-UP AIR SIZING: COMMENTARY

Ted Kesik and Michael Lio

The 1987 campaign to build a record number of R-2000 homes is underway. Across Canada new R-2000 builder recruits and updated design evaluators will undertake to extend the stock of R-2000 homes available to Canadian home buyers. Somewhere in the midst of this activity, new R-2000 Technical Requirements and the proposed Ventilation Guidelines may emerge (SOLPLAN REVIEW #12).

After much consideration we decided to follow up on articles in SOLPLAN REVIEW with a commentary on the proposed make-up air requirements within the new R-2000 Technical Requirements. Having conducted a seminar for senior R-2000 design evaluators from across the country in early December 1986 and being involved in the first 1987 builder workshop in Ontario, we realized that no single issue seemed to attract as much controversy.

The implications for the make-up air requirements remain to be fully assessed. For the moment R-2000 housing starts can enter the Program under either the present or new Technical Requirements. Thus we feel this is the time for this commentary. We make it in the hope of starting a constructive dialogue among those committed to the goals of the R-2000 Program.

As building scientists and practicing engineers, we agree with the need to limit pressure imbalances across the building envelope as long as the full implications on their possible detriment to the health and safety of occupants are not known. Some may argue that while the need to limit positive pressure imbalances is based on practical envelope considerations, the case for continuous and intermittent negative pressure imbalances demands further study. It may well be that the 10Pa and 20Pa limits set out by the R-2000 program will be revised over time. However, the issue at hand is clearly whether the proposals set out in the make-up air provisions of the proposed Ventilation Guidelines can effectively guarantee the reduction of these imbalances, both positive and negative, below the prescribed limits.

We feel that there have been a number of factors which have not been considered by the Program. Some of these are purely technical while others are of a practical nature. We hope that readers will critically evaluate our statements within the context of their local building practices.

First of all, there is not a one-to-one correlation between the equivalent leakage area (ELA) and the actual leakage area of a building envelope. If buildings were thin walled containers with no gravity acting on them and with no internal partitions then we could reasonably assume that the pressure difference across the envelope and any openings in it was uniform. Fortunately for home dwellers this is not the case.

The influence of gravity on stack and wind pressures will significantly affect the amount of air flowing through a make-up air duct. The flow through any opening is a function not only of its size, but of the pressure difference acting across it. Its location with respect to the neutral pressure plane and predominant zones of dynamic pressure is therefore critical. Moreover, the interior partitions of a dwelling act as a series of baffles and dampers which make some openings behave as smaller equivalent openings - a situation somewhat like the effective cross-sectional area of an equivalent length of duct which provides resistance to flow.

For this reason, sizing make-up air ducts involves some knowledge about the equivalent length of duct provided by the geometry of the building itself. This leads to the practical question, *"How large does a make-up air duct located in the basement have to be to correct the pressure imbalance introduced by the operation of an exhaust fan on the first or second floor?"*. Our experience indicates that this will not be the size calculated from the air flow versus envelope pressure curve produced by a fan depressurization test (conforming to CGSB Standard CAN2-149.10-M86).

The reason for this is that the test requires all of the doors in the house to remain open during the test. In our example above it is likely that the basement door in a home will remain shut during normal occupancy. With the internal geometry of a dwelling altered, a redistribution of actual leakage openings' equivalent areas can take place. The fan depressurization test is only valid for the set of conditions under which it is performed.

A different curve will result whenever the internal resistance to air flow in a building is significantly increased. When the equivalent leakage area is reduced in this manner, the pressure imbalance across the building envelope is increased to achieve the same flow rate measured by the fan depressurization test (which assumes all the interior doors are open). The resulting curve may indicate that for a specified flow rate the pressure difference across the envelope exceeds prescribed limits. The extreme situation is if we consider the case where the door between the basement and the main floor is airtight. A make-up air duct of any size (located in the basement) would have no effect whatever on the pressure imbalance resulting from the operation of an exhaust fan on any of the upper floors.

A second complication is introduced when an attempt is made to decide which of many possible curves to use for sizing the make-up air duct. This technical discussion is being presented in order to place in perspective the assumptions used in determining the make-up air provisions as per the proposed R-2000 Design and Installation Guidelines for Ventilation Systems.

Technical issues aside, what about some of the practical concerns looming ahead? If HRV's, which warm up incoming outside air (by more than than half the difference between inside/outside air temperature) have been known to be shut off by discomforted occupants, what chance does a make-up air duct spewing icy air have of remaining open? How will builders who have worked with care and conviction react to the prospect of putting holes through their proudly tightened envelope? How will HOT-2000 account for the impact on energy consumption introduced by a make-up air supply of untempered outside air? Do we gamble that an R-2000 home will fall within that zone of acceptable leakiness which by-passes the make-up air requirement altogether?

Up to this point in the R-2000 Program's development a consensus has been reached in many areas involving health and safety. In all cases it has led to reliance on mechanically controlled systems. The new proposed make-up air provisions seem to be taking a step backwards. They appear incongruous with other aspects of the Ventilation Guidelines which demand a field confirmation of their adequacy.

As long as we continue to construct tighter building envelopes (for which there are sound technical reasons) and homeowners demand central vacuums, downdraft countertop barbecues, clothes dryers and open hearth fireplaces (glass doors aside) these practical concerns will confront technical innovation. We believe that the R-2000 Program is capable of rising to meet the challenge and hope that it can do so before the proposed new Ventilation Guidelines become mandatory.

So what can be done in the meantime? A number of constructive steps can be taken. The first is to determine whether the approach taken to make-up air provisions is sound. Like Greg Allen, our preference is for measures similar to those for gas furnaces and water heaters. Exhaust appliances should each have their own make-up air system, either hard ducted or mechanically supplied to the appliance. In this way occupants can operate all of them simultaneously in defiance of the statistically crafted criteria for continuous and intermittent pressure imbalances across the building envelope. In view of the trend to tighter building envelopes this approach to meeting make-up air requirements may produce the most favourable long term effects.

An equally important step to overcoming the challenges of evolving energy efficient housing technologies is to make the technical basis for newly proposed requirements of the R-2000 program or otherwise available to the low energy building community. Forums for dialogue are the best possible means of arriving at workable solutions. We share a commitment to the R-2000 Program with many of our colleagues across Canada and hope that our discussion is not misconstrued as a criticism of the Program's goals. Instead we hope that it is viewed as an example of the type of communication needed to make workable, energy efficient housing a desirable standard in Canada.

Ted Kesik and Michael Lio are principals in Habitechnica, a Toronto engineering and building science firm.

RIGID INSULATION BOARDS ARE THEY AS GOOD AS CLAIMED?

The thermal resistance of polyurethane and polyisocyanurate foam boards is subject to decrease with aging. In-service insulation values can be up to **28% less** than manufacturers R-value claims!

These insulations contain fluorocarbon gases which are used in the manufacturing process. Unfortunately, the thermal resistance decreases over time to almost the level of air blown foam boards (such as the "bead-boards") because the fluorocarbon gas is diffused through the cell walls over time.

The use of fluorocarbon set foam boards should be questioned on environmental grounds, as these are the gases that find their way into the upper atmosphere and eat away at the ozone layer in the earth's atmosphere. There is strong pressure to eliminate the use of fluorocarbons in all applications, so these insulation products may be on an endangered list in any case.

Recent tests on roof insulation applications in the United States by the Midwest Roofing Contractors Association have underlined the need for insulation ratings to be based on proven long term thermal effectiveness. Field studies to provide this information verification are almost non-existent.

The study showed that almost 30% of thermal resistance value loss occurred over a period of 3 years after manufacture. The study looked at insulation samples from a number of buildings (the average roof age was about 3 years) and at insulation samples that had been sitting in warehouse storage for 3 years.

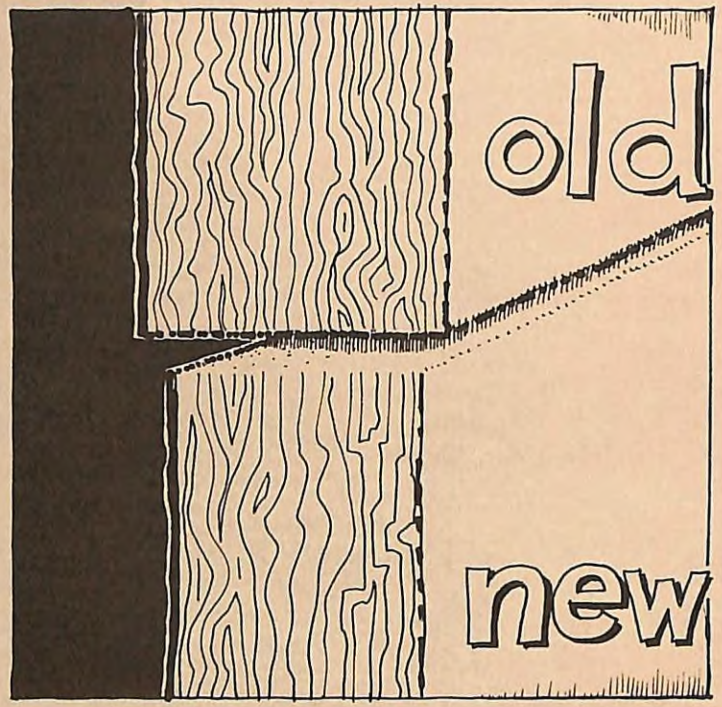
Standard testing procedures and manufacturer's product information uses 6 month aged values.

The average R-values of polyisocyanurate boards was found to be **5.56 per inch**. This is considerably below the typical values of 7.2-9 per inch that are claimed! The R5.56/inch is the R-value that the association is now proposing be used. An important finding was that thermal decay occurred even on foil faced boards which supposedly have low permeability.

The R-2000 program has begun to use a value of R6 per inch, rather than the much higher manufacturer's claims.

How significant are these findings? If a material does not perform as assumed, it can have an adverse effect on overall building performance. In an extreme case the mechanical system may not be adequate for the house because it was sized based on a different assumption.

NEW FROM FIBERGLAS CANADA



Fiberglass Canada Inc. has announced changes in their batt insulation products meaning that most batts now are thinner for the same insulating value.

R-8 batts has been reduced in thickness to 2 1/2" (from 2 3/4"). **R-31** batts are now 8 3/4" thick (from 11 1/4"), **R-35** batts are now 9 7/8" thick (from 12") and **R-40** are now 10 3/8" thick (from 12 1/2").

Reduced thicknesses of insulations allows attic/ceiling applications to exhibit a more uniform distribution of R-values across the total roof area. This is especially beneficial at ceiling perimeter edges, where unobstructed ventilation is important.

In addition, they are offering two versions of **R-28** batts - the standard is now 8" thick (from 8 1/2"). In addition, they can provide a 7" thick batt.

A new product available on demand is an **R-16** 4" thick batt. It is designed to meet CMHC requirements where insulation values must be increased for steel stud construction.

LEBCO COMMENTARY

Is low energy building becoming too successful? Is the market penetration of R-2000 and similar housing too high?

If we look at statistics, one can doubt it. R-2000 houses don't even account for 1% of total housing starts in Canada (although quite likely several times that number of 'clones' or 'look-alikes' are being built outside the program).

However, the impact of the program is beginning to be felt as more builders go through the training courses and start to apply what has been learned in their day to day work. The trend is pointing to more construction using the knowledge passed on by builder courses such as those put on the R-2000 program.

Low energy housing does not only mean energy conservation. The product of low energy construction is housing that is of better quality, more comfortable, more healthy and safer for the occupants.

In spite of the benefits (and perhaps because of the growing success and public interest in such housing) those who feel threatened may be preparing a campaign against R-2000 type building standards.

Gas utilities are hesitant to service developments that are being built to low energy standards, on the basis that they will not recover their servicing costs.

We have recently heard of at least one private utility that is monitoring the performance of low energy houses compared to 'standard' under insulated houses. We hope that the comparison will not only compare net energy used (this is easy to determine - just look at the fuel bills) but also the occupant interaction with their house - this is far more difficult.

Factors that must be evaluated include the number and type of appliances that the family uses - such as hair dryers, hot tubs, sauna, electric goods, freezers, refrigerators, dishwasher. Some, such as fridges and freezers, can have a major impact on energy consumption, as they are operating continuously, and can easily use up $100 of electricity per year (at $0.05/kwh).

Resident life style can have major a impact on energy consumption. How many members in the family, and what are their ages? Does the family entertain a lot? What kind of hobbies do they have? If someone does a lot of entertaining, considers cooking a hobby and regularly contributes home baking to community groups, they are going to use considerably more energy than someone who does none of this.

Indoor temperature settings are important on total energy consumption. If someone uses a night setback thermostat, keeps indoor temperatures generally low, and keeps domestic hot water temperature settings low will obviously use much less energy than someone who keeps indoor temperatures at very high levels for 24 hours per day.

B.C. Hydro suggests that in the colder parts of B.C. (northern/central interior) for each 1^{o}C reduction in temperature setting annual space heating will be reduced by 6.8-8.3%. With an 8 hour night setback space heating energy consumption can be reduced by 2.2-3% per ^{o}C. So that two identical houses, located side by side, with similar occupancy but different temperature settings will have significantly different energy use patterns.

It may seem obvious that these types of considerations should be made, yet they are the most difficult to monitor and quantify. You can put a meter on any appliance in the house and measure its performance and consumption over a period of time. You can't put a meter on people and their activities!

It would be unfortunate if utilities were to start aggressively putting down programs such as R-2000, just on the basis of an imperfect and too narrow economic analysis. There is a danger that if such campaign were to be mounted, some of the drive to implement major technological improvements in housing construction may be lost in the dust-up about whether or not there is an energy saving to be effected by a given building practice or approach.

Unfortunately, the private utilities, from a business perspective, have to keep a very narrow, short term outlook. If they don't sell their product today, they don't make money for their investors, and they will soon be out of business. Yet the common good of society requires that for energy use a longer term view be taken. Otherwise, what is going to happen a few years down the road, when the current

"energy glut" disappears? Who is going to pay the consequences of a shortsighted view? We doubt that the utility at that point will be willing or able to do anything about it.

The motivation of utility studies and the study methodology must be carefully assessed to ensure that they are honest.

SUBSCRIBE TODAY!

solplan review

SOLPLAN REVIEW: The independent newsletter of energy efficient building practice.

Please enter a 1 year subscription to SOLPLAN REVIEW at $24.00 per year.

Payment enclosed ○ Please bill us ○

Please charge to my credit card:

VISA ○ MASTER CARD ○ AMERICAN EXPRESS ○

Expiry date: ____________

Card Number: ______________________________
Signature: ______________________________
NAME: ______________________________

ADDRESS: ______________________________

____

POST CODE: ____________________

STUDENTS: Student subscription rate $12.00 per year available to full time students. Proof of student status required. Orders must be prepaid.

the drawing-room graphic services ltd.
box 86627 north vancouver b.c. V7L 4L2